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REPORT TO THE  
GOVERNOR'S CABINET COUNCIL ON  
ENVIRONMENTAL PROTECTION

**A Strategy For The Reduction Of  
Nonpoint Source Pollution  
From Transportation-Related Activities  
In Michigan**

SUBMITTED BY

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AUGUST, 1985



STATE OF MICHIGAN



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August 23, 1985

The Honorable James J. Blanchard  
Governor of Michigan  
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Lansing, Michigan 48909

Dear Governor Blanchard:

On behalf of the Transportation Nonpoint Source Pollution Subcommittee of the Governor's Cabinet Council on Environmental Protection, we are pleased to submit our final report entitled, "A Strategy for the Reduction of Nonpoint Source Pollution from Transportation Related Activities in Michigan". This report represents one component of the Cabinet Council's overall program addressing urban, rural, and transportation related nonpoint source pollution.

Transportation related nonpoint source pollution is of concern because of the presence of pollutants in stormwater runoff from highways, urban streets, rural roadways, airports, railroads and other means of transportation. In many instances, the runoff from transportation facilities may not cause water quality problems. However, the potential to cause a problem should be a significant consideration during the planning, construction and maintenance of our transportation system. Based on nationwide studies, it can be concluded that sediment, heavy metals, nutrients, pesticides and deicing salts from runoff are entering Michigan's waters. These pollutants represent potentially serious environmental impacts.

This Strategy includes a discussion of runoff pollutants and their potential impact on surface waters of the state. Present management practices used by Michigan Department of Transportation to avoid or reduce potential environmental problems are identified in the Strategy. Recommendations for further reduction of water quality problems associated with transportation facilities are also included in the Strategy.

Many individuals from the Michigan Department of Natural Resources and the Michigan Department of Transportation contributed to the development of this Strategy. Their hard work and support for this project made it possible.

Governor Blanchard

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We also appreciate the leadership and commitment which you have given in addressing the environmental concerns associated with the nonpoint source pollution. This concern for the environment and specifically the quality of the waters of the state will benefit all Michigan citizens.

Sincerely,



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## EXECUTIVE SUMMARY

Significant improvement in the quality of Michigan's water resources has been achieved since passage of the Federal Clean Water Act (1972) and the recent amendments to Michigan's Water Resources Commission Act (P.A. 245, 1929). Most of the progress in water quality improvement has been accomplished by increased control of point source pollution. Nonpoint sources of pollution are now recognized as significant factors affecting water quality. The Great Lakes and Michigan's inland lakes and streams are being polluted by rural, urban and transportation related nonpoint sources.

As one of his environmental priorities, Governor James J. Blanchard directed the Cabinet Council on Environmental Protection to develop a statewide nonpoint source pollution strategy. The Governor's Cabinet Council assigned the responsibility of developing the transportation portion of the nonpoint source strategy to the Michigan Department of Natural Resources and Michigan Department of Transportation.

For this portion of the nonpoint strategy, TRANSPORTATION NONPOINT SOURCE POLLUTION IS DEFINED AS THE CONTAMINATION OF SURFACE AND GROUND WATER RESOURCES BY MATERIALS THAT RESULT FROM TRANSPORTATION-RELATED ACTIVITIES.

Michigan has 5,000 miles of railroad, 280 airport facilities, and nearly 117,000 miles of highways, urban streets and rural roadways. Stormwater runoff originating from transportation related landuse facilities contains pollutants that are nonpoint in origin and represent potential water quality problems when discharged to surface waters.

In general, contaminants from roadway runoff are not of the magnitude to cause severe water quality problems. However, potential water quality impacts due to transportation runoff include changes in the chemical and physical parameters of the receiving waters which may directly or indirectly influence the designated uses of Michigan's water resources. Surface water impacts that have been reported to be associated with stormwater runoff from transportation facilities include increased concentrations of heavy metals, pesticides, plant nutrients, particulate materials, deicing agents and pathogenic bacteria. Transportation related facilities represent a potentially significant nonpoint source of pollutants and need to be addressed in order to protect the quality of Michigan's water resources.

The following is a listing of recommendations developed by Michigan Department of Transportation (MDOT) and Michigan Department of Natural Resources (DNR) in response to the concern over transportation-related nonpoint source pollution:

1. As a joint cooperative effort MDOT and DNR should establish criteria to be used to categorize trunkline project activities having a potential adverse impact on water quality.

2. As a joint cooperative effort MDOT and DNR should initiate a formal study approach to evaluate and analyze the cost and effectiveness of environmental mitigation efforts implemented to reduce water quality impacts.
3. MDOT and DNR should cooperate in the development of information and education materials and provide information and training to local transportation agencies regarding the potential impact of their activities on the water resources of the state.
4. DNR, with assistance from MDOT, should investigate and evaluate the potential for water quality problems from non-roadway modes of transportation.
5. MDOT, with assistance from Michigan Department of Agriculture and DNR, should review its current drainage design practices dealing with the effects of roadway drainage on water quality.
6. MDOT, with assistance from DNR, should review their current soil erosion and sedimentation control practices and designate the Engineer of Construction to be responsible for project actions required by the Soil Erosion and Sedimentation Control Act on trunkline projects.
7. MDOT, with assistance from the Toxic Substance Control Commission, DNR and MDA, should annually evaluate and report to the Michigan Environmental Review Board on its herbicide application program.
8. MDOT should continue to evaluate its winter maintenance program and attempt to establish Michigan as the focal point of exploring alternatives to deicing salt in the Great Lakes Region.

The reports or plans that are developed for implementation of the above recommendations by the appropriate agencies will be submitted to the Governor's Cabinet Council.

## INTRODUCTION

As the focal point of the Great Lakes basin, the State of Michigan leads the nation with 3,250 miles of freshwater shoreline and approximately 39,000 square miles of four Great Lakes within its political boundaries. There are 36,000 river and stream miles and 11,000 inland lakes of 10 acres or more. These unique and abundant waters provide water supply, recreation and navigation for Michigan's 9.2 million residents, while supporting industry and tourism so important to the State's economic development.

The quality of Michigan's water resources range from virtually pristine to severely degraded. Michigan's water quality is generally good throughout the state with high quality streams and lakes found in most areas. However, water quality problems exist. In areas identified as having water quality problems the impacts can usually be attributed to point sources such as municipal wastewater treatment facility discharges, industrial discharges and/or diffuse, "nonpoint", sources.

Nonpoint pollution is literally defined as pollutants that are not discharged from point sources. However, nonpoint pollution may also include many small point sources (rural septic tanks, small animal feedlots, combined sewer overflow, stormwater discharge, etc.). Nonpoint pollution originates from many diffuse sources and types of land and water use activities. Major activities in Michigan which contribute nonpoint pollutants include crop production, livestock management, urban development, transportation-related activities and forest management.

To address nonpoint source water quality problems and other environmental concerns in Michigan, Governor James Blanchard established the Cabinet Council on Environmental Protection in October of 1983. A responsibility assigned to the Cabinet Council was to develop a comprehensive statewide nonpoint source water pollution control strategy. As part of the statewide nonpoint strategy Governor Blanchard asked that the Departments of Natural Resources, Transportation and Agriculture develop nonpoint source pollution control plans addressing urban, rural, and transportation-related sources. The Michigan Department of Natural Resources (MDNR) has been designated as the lead agency in developing the urban strategy; a rural nonpoint strategy has been developed by the Michigan Department of Agriculture (MDA); and this transportation nonpoint strategy was developed as a joint effort by MDNR and Michigan Department of Transportation (MDOT).

## BACKGROUND

Significant improvement in the water quality of Michigan streams and lakes has been achieved since passage of the Federal Water Pollution Control Act (or Clean Water Act) of 1972 (P.L. 92-500) and the recent amendments to Michigan's Water Resources Commission Act (P.A. 245, 1929). Although the control of nonpoint source pollution is an objective of P.L. 92-500, most of the progress in water quality improvement has been accomplished by controlling municipal and industrial point sources. Point sources enter the environment at distinct locations. Consequently,

they are easy to identify and have received the highest priority in pollution control efforts.

Since 1972, over 3.3 billion dollars have been invested in Michigan by federal, state and local governments for point source water quality control at municipal sewage treatment facilities. Significant additional sums have been expended by industries for point source controls. As point sources came under control the relative importance of nonpoint sources became more apparent.

Nonpoint pollution is now recognized as a major contributor to water quality problems in many inland lakes, the Great Lakes, streams and groundwater. Recent federal, state and international programs, including the Pollution From Land Use Activities Reference Group (PLUARG), the Nationwide Urban Runoff Program (NURP) sponsored by United States Environmental Protection Agency (EPA), and the Areawide Water Quality Management Plans conducted under Section 208 of the Federal Clean Water Act have assessed water quality problems at local, state, regional, national and international levels.

Large quantities of stormwater runoff originating from transportation-related facilities are annually discharged either directly or indirectly to Michigan's waters. In most instances contaminants discharged are not of the magnitude to cause severe water quality problems. However, roadway runoff contains contaminants which can potentially have significant impacts on the Great Lakes, inland lakes, streams and groundwater. Contaminants identified in runoff waters and of concern include particulate material, deicing agents, heavy metals, hydrocarbons, nutrients, pathogenic bacteria and pesticides.

For the purpose of this strategy:

TRANSPORTATION NONPOINT SOURCE POLLUTION IS DEFINED AS THE CONTAMINATION OF SURFACE AND GROUND WATER RESOURCES BY MATERIALS THAT RESULT FROM TRANSPORTATION-RELATED ACTIVITIES.

Transportation activities include construction, use, and maintenance of all roadways in Michigan, regardless of whether under state, county or city jurisdiction, and also other modes of transportation such as airports, railroads, and water-related transportation. While this strategy focuses on the management practices and activities of the Michigan Department of Transportation (MDOT), the intent is that all transportation-related activities regardless of jurisdiction or mode will, as appropriate, contribute to protect Michigan's waters from nonpoint source pollution to the greatest extent practical.

This strategy report focuses on MDOT because: on a statewide basis MDOT is involved in a significant degree of activity which has a potential to impact the state's surface and ground waters; and MDOT's responsibilities, contacts, and centralization of transportation-related functions place it in an advantageous position to educate, train, and work with other local and regional transportation-related authorities to develop an appropriate role for them concerning nonpoint source pollution. This is

consistent with recommendation 15 of the "Groundwater Protection Initiatives" published in September 1984(6).

The objectives of this transportation nonpoint source strategy are:

1. To provide background information on the contaminants present and their concentration or loading in stormwater runoff from transportation-related activities.
2. To describe potential impacts of runoff contaminants on water quality.
3. To compare existing information collected nationally on roadway runoff contaminants to present Michigan Water Quality Standards.
4. To describe existing Michigan environmental legislation governing the effect of transportation-related activities on the surface waters of the state.
5. To describe and improve current MDOT, county, and city practices regarding nonpoint source contaminants originating from roadways.
6. To provide recommendations for preventing or reducing nonpoint source water quality problems from transportation-related activities.

Nonpoint source groundwater problems in Michigan have been addressed in the report entitled 'Groundwater Protection Initiatives' (6). Recommendations within the groundwater report specifically address groundwater nonpoint problems from chemical spills occurring along roadways and railroads and the potential groundwater hazard from pesticide application. Recommendation 13 within the Initiative calls for a statewide nonpoint source inventory and evaluation of significant existing or potential groundwater contamination from nonpoint sources. It is also recommended that the State review existing policies and programs with regard to nonpoint source pollution and specifically address the need for measures to control groundwater contamination from pesticides, brines, fertilizers, herbicides, road salt, and transportation spills.

#### ROADWAY SURFACE CONTAMINANTS

The purpose of this portion of the report is to identify contaminants that may be found on typical road surfaces and may potentially cause water quality problems. Much of the information presented is from studies undertaken in other parts of the nation. Although not specific to pollutants contained in transportation runoff for Michigan, this information provides an indication as to the types of problems that may exist in the State.

In many instances, the runoff from roadways may not be of the extent necessary to cause water quality problems. However, the potential to cause a water quality problem should be of significant consideration during the planning, construction and maintenance of our roadway system.

A listing of surface water pollutants associated with roadway use and their primary sources is provided in Table 1. The contaminants present at any given location will depend on factors such as traffic volume, traffic speed, climatic conditions, surrounding land use, exhaust emission regulations, highway maintenance policies, and occurrence of accidental spills (7, 17, 19). As indicated in Table 1, motor vehicles and roads contribute a broad spectrum of materials in several ways: leakage of fuels and lubricants; wear of vehicular parts; exhaust emissions; and rusting of parts. Atmospheric fallout, pavement and bridge wear, and deicing compounds are other common sources of roadway surface contaminants (17).

Movement of contaminants deposited on roadway surfaces to a receiving water body occurs via two principal mechanisms: "washoff" by rainfall or snowmelt and "blowoff" by wind and/or vehicular turbulence (7). The rate at which rainfall removes contaminants from street surfaces is dependent on rainfall intensity and street surface characteristics. Intense storms remove more street pollutants than light storm events. Nearly one-half of the plant nutrients (phosphorus, nitrogen), one-fourth to one-half of the heavy metals and over one-third of the pesticides found on street surfaces are associated with the finer size classes of particulate materials.

#### RUNOFF CONTAMINANT CONCENTRATIONS AND LOADINGS

Concentration and loading data for selected roadway contaminants present in stormwater runoff are summarized in Table 2. The values are means for runoff samples taken during 159 storm events within four representative U.S. cities. Roadway runoff volume and associated contaminant concentrations are strongly influenced by rainfall intensity, area and configuration of drainage system, traffic volume, climatic conditions and percent of paved versus unpaved areas within the drainage area (8). Loadings for most parameters were highest for all-paved sites and attributed to the higher contaminant wash-off efficiency of accumulated material from impervious surfaces. Solids, heavy metals and chloride loadings were found to increase during winter periods for those sites using salt/sand deicing materials. Mean BOD<sub>5</sub> (5-day biochemical oxygen demand) values, during the initial roadway runoff period which impacts the amount of oxygen dissolved in the water, are comparable to estimates for a well operated secondary municipal wastewater treatment plant (8). Maximum values (Table 2) for many of the pollutants indicate that extreme loadings are possible.

In describing the pattern of pollutant discharge during a runoff event, the term "first flush" is commonly used for the initial portion of the runoff which typically contains the highest pollutant loadings (7, 8, 19). Nationwide research indicates that the majority of pollutants are discharged into receiving waters during the initial stages of a storm and decrease with time. Peak loading rates last for a relatively short time period, but may under certain conditions reach extreme levels. However, the first flush discharge pattern varies with each drainage system and each rainfall event. The first flush pattern is less noticeable during storms having low, even rates of runoff and also when rainfall events

Table 1. Common highway runoff contaminants and their primary sources (7, 12).

Contaminant Type	Examples	Primary Source
Particulates	Dust, dirt, gravel, fine residue	Pavement wear, vehicles; atmosphere; highway maintenance
Nutrients	Nitrogen, phosphorus	Roadside fertilizers; atmosphere
Heavy Metals	Lead	Auto exhaust (leaded gasoline); tire wear (filler); lubricating oil and grease; bearing wear
	Zinc	Tire wear (filler); motor oil (stabilizing additive); grease
	Iron	Vehicle rust; highway structures; moving engine parts
	Copper	Metal plating; bearing and bushing wear; brake lining wear; herbicides
	Cadmium	Tire wear (filler material); fungicide applications
	Chromium	Metal plating; brake lining wear
	Nickel	Diesel fuel, gasoline exhaust; metal plating; lubricating oil; bushing wear, asphalt paving; brake lining wear.
Inorganic Salts	Mercury	Atmosphere fallout
	Sodium, Calcium Chlorides	Deicing salts; grease
	Sulfates	Deicing salts
Petroleum Products	Oil, grease, gasoline	Deicing salts; fuel; roadway beds
Pesticides/ Herbicides	Methoxychlor; methyl parathion;	Spills; leaks; antifreeze; asphalt surface leachate
		Spraying highway right-of-way

Table 1 (continued)

Contaminant Type	Examples	Primary Source
Pathogenic bacteria.	Coliform bacteria (indicator)	Soil; litter; bird droppings, trucks hauling livestock or livestock waste.
PCB's	Polychlorinated biphenyls	Atmosphere deposition; catalyst in synthetic tires.
Other Compounds	Asbestos	Clutch and brake lining wear
	Rubber	Tire wear

Table 2.

Average contaminant concentrations and loadings in roadway runoff for four U.S. cities.<sup>1</sup>

Contaminant Sampled	Concentration (mg/l)		Loading (lbs/acre)	
	Average <sup>3</sup>	Range <sup>2</sup>	Average <sup>3</sup>	Range <sup>2</sup>
TS	1147	145-21640	51.8	0.04-535.0
SS	261	4-1656	14.0	0.008-96.0
BOD <sub>5</sub>	24	2-133	0.18	0.0-4.1
TOC	41	5-290	2.1	0.002-11.5
COD	147	5-1058	6.9	0.004-34.3
TKN	2.99	0.1-14	0.15	0.0-1.04
NO <sub>2</sub> + NO <sub>3</sub>	1.14	0.01-8.4	0.69	0.0-0.42
TPO <sub>4</sub>	0.79	0.05-3.55	0.05	0.0-3.6
CL	386	5-13300	13.0	0.008-329.0
Pb	0.96	0.02-13.1	0.06	0.0-0.48
Zn	0.41	0.01-3.4	0.02	0.0-0.12
Fe	10.3	0.1-45.0	0.50	0.0-3.5
Cu	0.10	0.01-0.88	0.01	0.0-0.029
Cd	0.04	0.01-0.40	0.002	0.0-0.14
Cr	0.04	0.01-0.14	0.003	0.0-0.29
Hg x 10 <sup>-3</sup>	3.22	0.13-67.0	0.001	0.0-0.002
Ni	9.92	0.1-49.0	0.27	0.007-1.33
TVS	242	26-1522	9.34	0.01-44.0
VS	77	1-837	3.7	0.004-28.2

To obtain kg/ha multiply lbs/acre by 1.12

<sup>1</sup>Taken from Gupta et al. (1981) for Denver, Harrisburg, Milwaukee, Nashville.

<sup>2</sup>One site was an elevated bridge (paved only), one site was an all grassy right-of-way (unpaved), and averages for other four sites included both paved and unpaved areas.

<sup>3</sup>Average of 151 storm events. However, not all parameters were monitored for every event.

occur close together which prevents accumulation of contaminants on street surfaces.

### ROADWAY RUNOFF AND ITS IMPACT ON SURFACE WATERS

In general, contaminants from roadway runoff are not of the magnitude necessary to cause serious water quality problems. However, the potential to cause water quality problems from roadway runoff exists. In general, the environmental impact of transportation runoff will depend upon the type and amount of pollutants delivered to and the characteristics of the receiving water body.

Few studies have documented the environmental problems associated with stormwater runoff from transportation-related activities. However, results from studies conducted under the Nationwide Urban Runoff Program (NURP) and similar studies that have dealt with urban stormwater runoff provide a framework for examining potential surface water problems associated with transportation-related runoff (1, 17, 21).

There are several ways in which stormwater or snowmelt runoff from transportation-related activities may impact receiving surface waters. As previously discussed, stormwater runoff from roadways often results in high-level short-term increases of particulates, toxic materials, nutrients and oxygen demanding substances. As particulates present in roadway runoff are delivered to surface waters and settle out, the associated contaminants may exert long-term impacts on surface water quality and the aquatic organisms. Results from urban runoff studies indicate that urban runoff particulates act as a constant source of small amounts of slowly dissolving toxic materials, such as heavy metals, PCB's, pesticides, grease and oil (19, 24). Other types of long-term impacts include depressed levels of dissolved oxygen, accumulation of toxics, and increased eutrophication (aging of lakes) as a result of nutrients contained in the runoff. In addition, a marked increase in river and stream flow resulting from stormwater runoff may cause scouring and resuspension and/or redeposition of pollutants previously deposited in sediments.

The following sections provide insight into the potential impacts associated with stormwater runoff. The environmental impact of specific contaminants that occur in roadway runoff, notably lead, deicing salt, and various pesticides are reasonably well documented. However, little information is available as to how these contaminants impact stream and lake quality when present at levels in stormwater runoff.

#### Hydrology

Roadway development results in the removal of vegetative cover and sometimes locating impervious surfaces adjacent to lakes, streams and wetlands. Intense rainstorms will result in rapid runoff, sudden peak flows, and altered water levels. Fraser (1972), in a review of stream flow, considered flow velocity to be the dominant physical factor affecting stream life. Stream flow velocity will influence fish food and habitat availability through its impact on invertebrate life, resuspension of bottom sediments, stream turbidity, bottom channel

erosion and sedimentation (3). Most stream dwelling organisms are adapted to a particular flow velocity and any major change in velocity may alter habitat availability.

### Particulates

Sediment particles contained in roadway runoff, upon delivery to surface waters, will influence water turbidity, temperature and act as a carrier of heavy metals, pesticides and nutrients. Major increase in the suspended sediment load of streams has been shown to result in reduced survival and hatching of fish, decreased aquatic insect production, and a reduction in substrates necessary for aquatic plants (10, 25). King and Ball (1964) reported that construction of I-96 in 1961 (prior to use of sedimentation controls) along the Red Cedar River near Fowlerville, Michigan resulted in a temporary reduction of stream quality. In waters where quality fisheries are to be maintained, even temporary high concentrations of suspended solids should be prevented, especially in trout and salmon spawning grounds (1).

### Deicing Salts

The use of roadway deicing compounds, primarily sodium chloride (rock salt), has reached a seasonal average (1965-1984) application level in Michigan of nearly 300,000 tons (Table 3). Deicing compound use will vary with the severity of the winter and the number of winter storms. Salt compounds used in roadway deicing may reach surface waters: 1) as dissolved salts in roadway runoff; 2) following percolation through the soil to the water table; or 3) directly when ice and snow containing salts are dumped into watercourses (7). During percolation through the soil the sodium cations (Na<sup>+</sup>) become associated with clay particles present while the anions (Cl<sup>-</sup>) either percolate to the water table or are discharged to surface waters.

Potential environmental impacts of roadway deicing salts include: damage and mortality of roadside vegetation (14, 15), increased salt concentrations in soils, lakes and streams near highways (8, 9, 18, 24) and increased salt concentrations in groundwater supplies (5, 8). Recent studies (13, 16, 20) indicate that a substantial portion of the total chloride loading to Lake Michigan and Lake Erie is directly attributable to winter use of road salts.

Although numerous studies have demonstrated salt concentrations to increase dramatically in surface waters adjacent to roadways (5, 7, 8, 18), a significant impact on aquatic organisms has not been readily documented. In general, salt loadings are temporary and normal dilution may be great enough to reduce the immediate problem. However, surface waters which lack an outlet or have long flushing times may experience continually increasing salt concentrations which may influence aquatic organisms.

### Heavy Metals

Stormwater runoff from transportation related activities may contain elevated concentrations of several heavy metals (lead, zinc, iron,

Table 3. Annual deicing salt used by Michigan Department of Transportation/Contractor<sup>1</sup> on trunklines.

<u>Year</u>	<u>Salt Use (tons)</u>	<u>Salt Use (tons/"E" mile)<sup>2</sup></u>
1965-1966	153,094	13.02
1967-1968	238,182	19.63
1969-1970	322,729	26.3
1972-1973	329,687	26.4
1973-1974	301,268	24.2
1974-1975	333,697	26.3
1975-1976	313,315	24.05
1976-1977	309,627	23.36
1977-1978	318,801	23.73
1978-1979	337,485	24.94
1979-1980	275,920	20.23
1980-1981	302,574	22.08
1981-1982	354,982	25.91
1982-1983	204,496	14.92
1983-1984	379,441	27.44

<sup>1</sup>Data supplied by MDOT

<sup>2</sup>An "E" mile - equivalent mile or lane mile

copper, cadmium, mercury, nickel, chromium). Concern over the release of heavy metals into the environment has led to the production of an extensive body of literature. Toxicity tests have shown that heavy metals at high concentration can cause delayed embryonic development, suppressed reproduction, inhibition of growth rates, and mortality among aquatic organisms (23). However, the ecological significance of laboratory toxicity test results are unclear because of the highly unnatural experimental conditions. Levels used in toxicity tests may be several orders of magnitude above concentrations that occur in fresh waters. In addition, the toxicity of heavy metals has been shown to vary with their chemical properties and with habitat variables, such as temperature, pH, oxygen content, and water hardness (26). Additional research is needed on heavy metals and other potentially toxic contaminants present in transportation runoff in order to adequately describe 1) the availability of contaminants, 2) water quality impacts, and 3) biotic responses to high-level, short-term exposure and low-level, long-term exposure.

#### Other Contaminants

Other contaminants, including nutrients (nitrogen, phosphorus), petroleum products, polychlorinated biphenyls (PCBs), asbestos, rubber, pathogenic bacteria, and pesticides have also been detected in transportation runoff and represent potential surface water problems. Increased nutrient loadings may cause nuisance aquatic plant growths and eutrophication. Excessive concentrations of pathogenic bacteria can prevent the receiving water from being used for recreational or water supply purposes. Kobriger et al (1983) strongly recommend that pesticides not be used on road shoulders and ditches that are adjacent to surface waters. The environmental impact of petroleum products, asbestos materials and PCBs at levels in roadway runoff requires further investigation.

#### Accidental Spills

Many potentially toxic materials are carried along transportation right-of-ways which either cross or are adjacent to surface waters. There is a potential for a toxic material spill which would result in an immediate short-term and/or long-term impact on the adjacent aquatic ecosystem. Michigan's Department of Natural Resources Pollution Emergency Alerting System (PEAS) responds to calls involving spills or release of potential pollutants. Michigan's Department of Transportation is notified of spills on state trunklines while county road commissions are notified of spills on non-state roadways.

### SURFACE WATER PROTECTION

#### Water Quality Standards

The stated objective of the Federal Clean Water Act of 1972 (92-500) is "to restore and maintain the chemical, physical and biological integrity of the Nation's "waters". One of the mechanisms used to protect Michigan waters is through the General Rules of Public Act 245 of 1929 as amended (Water Resources Commission Act), which includes the Part 4 Rules, Water

Quality Standards. The goal of the Water Quality Standards is "to establish water quality requirements applicable to the Great Lakes, their connecting waterways and all other surface waters of the state".

All surface waters of the state are currently designated as a minimum for agricultural uses, navigation, industrial and public water supplies, "warm water fish" such as bass, pike, walleye, panfish and others and recreation such as swimming, wading, boating, water skiing and wind surfing. In addition, the Great Lakes, designated trout streams and designated trout lakes are protected for "coldwater fish" such as trout, salmon, whitefish and related species. In addition to describing designated uses, the standards also define parameters and criteria levels necessary to provide for or protect a water body for its designated uses.

Table 4 provides a summary of water quality standards for Michigan waters. Water quality standards for suspended solids, dissolved solids, and taste and odor producing substances are such that any discharge containing these substances may not exceed concentrations that would be detrimental to the receiving water's designated use. Plant nutrients shall be controlled to the extent necessary to prevent designated use impairment from point source discharges by application of methods utilizing best practicable waste treatment technology.

Rule 57(2) of Michigan's Water Quality Standards addresses the discharge of toxic materials. Discharge limits are calculated using values needed to protect designated uses. The Water Quality Standards, Rule 82, allow for designation of specific stream areas, or "mixing zones" where Rule 57 values do not apply.

Since waters of the state are protected for warmwater or coldwater fish, Rules 57 and 82 are used to calculate separate values for coldwater and warmwater designated streams if pertinent. These rules provide for the determination of chronic (long-term), acute (short-term) aquatic toxicity discharge limitations and drinking water values where there is a potential impact on drinking water intakes.

#### Roadway Runoff and Water Quality Criteria

It must be emphasized that pollutant concentrations in roadway runoff will vary considerably depending upon traffic volumes, drainage conditions, adjacent land use, and rainfall patterns. A comparison between standards and pollutant runoff concentrations is included within this strategy in order to express the potential environmental impact associated with transportation stormwater runoff. Information regarding the average or range in pollutant runoff concentrations are from studies conducted in four non-Michigan cities and are presented as being representative of conditions in Michigan.

The roadway runoff pollutant concentrations shown in Table 2 indicate that parameters such as total solids, chlorides and nutrients ( $\text{NO}_2$  +  $\text{NO}_3$  and  $\text{TPO}_4$ ) may not meet water quality standards. Concentrations of  $\text{BOD}_5$  may also result in standards violations.

Table 4. Summary of Michigan Water Quality Standards.

<u>Parameter</u>	<u>Standards</u>
Total Dissolved Solids (TDS)	500 mg/l monthly average; 750 mg at any one time.
Chlorides	150 mg/l at point of public water supply intake; 50 mg/l for Great Lakes and connecting waters; 125 mg/l monthly average for all other state waters.
Hydrogen Ion Concentration (pH)	6.5-8.5 in Great Lakes and connecting waters; 6.5-8.8 all other waters.
Phosphorus (P)	1.0 mg/l monthly average for point source discharges.
Fecal Coliform	200 organisms per 100 ml for total body contact recreation; 1,000 organisms per 100 ml for all other waters.
Dissolved Oxygen (DO)	6.0 mg/l minimum in Great Lakes, connecting waters, coldwater streams and lakes; 5.0 mg/l daily average in warmwater streams.
Ammonia (NH <sub>3</sub> )	Case-by-case
Chlorine	Case-by-case
Heavy Metals	Case-by-case
Organics	Case-by-case

Rules 57 and 82 provide for the determination of allowable chronic and acute aquatic toxicity discharge limitations. Chronic values protect the water resources for long term impacts while acute values protect for short term impacts. Table 5 provides a comparison between chronic and acute values, drinking water values and representative average and ranges of heavy metal concentrations in some roadway stormwater runoff. Roadway runoff concentrations included in Table 5 are values for 151 monitored storm events within four U.S. cities (Harrisburg PA, Nashville TN, Denver CO, and three sites in Milwaukee WI). Tables A-1 and A-2 in the Appendix A provide a summary of site characteristics and heavy metal runoff concentrations for the six sample sites.

Average roadway runoff metal concentrations exceeded acute values for cadmium, lead and mercury (Table 5) for cold and warm water streams. Chronic values are exceeded by all average metal discharge concentrations. Average runoff concentrations exceed the drinking water values for cadmium, lead, mercury, nickel and zinc. The range of runoff concentrations included in Table 5 varies from values less than water quality criteria to concentrations over 100 times the chronic values. This comparison of national studies of heavy metal concentrations in roadway runoff to Michigan discharge limitations indicates that runoff concentrations can potentially exceed limitations that are designed to protect the waters of the State.

#### New Federal Stormwater Discharge Regulations

Regulating the discharge of stormwater into the waters of the United States has long been a matter of concern. In dealing with the issue, EPA in 1973 distinguished among various types of stormwater, and exempted stormwater runoff discharges uncontaminated by industrial or commercial activity from the requirement to obtain a National Pollution Discharge Elimination System (NPDES) permit. EPA maintained that these discharges were ill-suited for inclusion in the NPDES permit program and better dealt with through nonpoint source controls.

As a result of legal challenges to EPA's authority to exempt stormwater discharges from permit requirements, regulations were published in the September 26, 1984, Federal Register. These new federal regulations will have a major impact on the control of stormwater runoff. In urban areas all stormwater discharges to waters of all states are to be considered as point sources and included within the NPDES permit program. Permit guidelines have not been developed by US-EPA to date.

In addition, commercial and industrial stormwater discharges outside the defined urban areas are required to apply for NPDES permits. The definition of an urban area is based on the 1980 Census and includes urban areas with a population of 50,000 or more. Included are contiguous areas which meet density criteria as defined by the Census Bureau.

#### Other Legislation that Protects Surface Waters

Surface waters in Michigan are also protected by the Soil Erosion and Sedimentation Control Act (P.A. 347, 1972), the Inland Lakes and Streams Act (P.A. 346, 1972) and the Pesticide Control Act (P.A. 171, 1976).

Table 5. Comparison of heavy metal discharge concentrations in roadway runoff<sup>1</sup> to Michigan Water Quality Standards<sup>2</sup>.

Parameter	Runoff Average <sup>3</sup> (µg/l)	Concentration Range <sup>3</sup> (µg/l)	Chronic Value (µg/l)	Acute Value <sup>4</sup> (µg/l)	Drinking Water Value (µg/l)
Cadmium	40	10-400	0.6	16(23)	3
Copper	100	10-880	47	164(331)	500
Lead	960	20-13,000	12	903	6
Mercury	3.22	0.13-67.0	0.2	1.6	0.009
Nickel	1920	100-49,000	152	5444	110
Zinc	410	10-3400	206	1956	600

<sup>1</sup>Concentrations of metals in roadway runoff taken from Gupta et al. (1981).

<sup>2</sup>Water hardness of 240 mg/l (CaCO<sub>3</sub>) assumed.

<sup>3</sup>Data for flow composite samples.

<sup>4</sup>Warmwater values are in parentheses when they differ from coldwater values.

<sup>5</sup>Values apply only to discharges directly impacting drinking water intakes.

Michigan's Soil Erosion and Sedimentation Control Act requires that prior to any earth change activity of over one acre and within 500 feet of a lake or stream, the developer or land owner must submit a soil erosion and sedimentation control plan. The plan must include designs for prevention of soil erosion and sedimentation and a proposal for continued maintenance of temporary and permanent soil erosion control devices.

The Inland Lakes and Streams Act regulates dredging and filling and requires an assessment of potential adverse environmental effects of construction activities (bridges, culverts, roads, etc.) involving lakes or streams. All transportation related construction activities are required to follow the guidelines of the Soil Erosion and Sedimentation Control Act and the Inland Lakes and Streams Act.

Michigan's Pesticide Control Act, in addition to regulating the distribution and labeling of pesticides, requires that certain restricted use pesticides be applied by or under the supervision of a certified pesticide applicator. Roadside maintenance activities involving the use of pesticides must follow the regulations outlined in the Pesticide Control Act.

RECOMMENDATIONS FOR IMPROVING MDOT'S CURRENT MANAGEMENT PRACTICES WHICH AFFECT WATER QUALITY

There are a number of highway runoff management practices utilized by MDOT that can affect surface and ground water quality. These are discussed in the context of Highway Planning, Design, Construction, and Maintenance. A number of recommendations have been included as a means of providing the best opportunity for significantly reducing pollution from the transportation-related nonpoint sources of stormwater runoff. These recommendations reflect a number of current practices that could be used on a more routine basis, could be improved on, or should be studied further for broader implementation. The recommendations should be explained to, implemented by, and improved on by county and municipal transportation agencies. They may also be applicable to railroads, airports and other modes of transportation.

Highway Planning Current Practices

To ensure compliance and consistency with state and federal statutes, regulations, and executive orders relating to environmental protection, all state trunkline proposals undergo an environmental review process prior to implementation. The Transportation Planning Services (TPS) Division maintains a professional environmental staff (botanist, archaeologist, wildlife biologist, fisheries biologist, agriculturalist, and resource development specialist) and engineers who review each project's description of work to assure that resources such as wetlands, streams, lakes, endangered species, wildlife, water quality, etc. are treated in a manner consistent with national, state, and local environmental goals. These goals generally involve preserving or enhancing specific environmental factors which are regulated or considered important.

Any proposal that has a potential to significantly affect the environment is coordinated early in the project development with the appropriate federal and state agencies, organizations, and local interests. For example, regular coordination is conducted with the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers (ACOE), U.S. and Michigan Departments of Agriculture, Michigan Department of Natural Resources (DNR), Michigan United Conservation Clubs, etc.

Relative to the degree of anticipated impact, any or all of these agencies indicate their concerns and may participate in on-site field reviews. As part of the early review and coordination process, an attempt is made to identify any locations where roadway runoff may have a significant effect on downstream water uses. X

TPS Division responds to all environmental concerns received from outside MDOT. This includes concerns received at the planning, design, construction, and maintenance stages. The TPS Division attempts to resolve all highway related environmental problems to the satisfaction of all parties involved. In the past, strategies used to mitigate environmental impacts, including impacts to water quality, have included:

1. Avoiding areas of concern by shifting a roadway or by selection of a more desirable alternative alignment.
2. Minimization of impacts by incorporating specific design features and construction methods into the project that will limit the extent or magnitude of the impacts.
3. Restoration or improvement of a natural area of concern by increasing its size and diversity and replacing its overall integrity and function.
4. Compensating for the loss of an important environmental feature by creating a similar or replacement feature at a new location.

Construction permits are required to be obtained by MDOT for new or extended culverts which encroach on defined water courses or floodplains. The permit applications are reviewed by the TPS Division to ensure compliance with current DNR and ACOE requirements and for inclusion of mitigation items. The permits required may include:

1. Act 346 P.A. 1972 requires an Inland Lakes and Streams Permit from the DNR for construction over or adjacent to inland lakes or streams.
2. Act 245 P.A. 1929, as amended, requires a Floodplain permit from the DNR for placement of fill into the floodplain adjacent to streams that have drainage areas greater than two square miles upstream of the crossing.
3. An ACOE Section 404 Permit under the Water Pollution Control Act is required for water courses with a flow greater than five cubic feet per second (cfs) or adjacent wetlands, as currently listed in the ACOE jurisdiction maps. This is a joint permit application with the DNR. The ACOE has delegated most permit issuance authority to DNR.
4. Act 203 P.A. 1979 requires a DNR Wetland Permit for the placement of fill into a wetland area.

The following are planning recommendations developed by the Transportation Strategy Task Group for the control of transportation nonpoint source pollution.

**RECOMMENDATION 1: AS A JOINT COOPERATIVE EFFORT MDOT AND DNR SHOULD ESTABLISH CRITERIA TO BE USED TO CATEGORIZE TRUNKLINE PROJECT ACTIVITIES HAVING A POTENTIAL ADVERSE IMPACT ON WATER QUALITY.**

MDOT performs a wide range of construction and maintenance activities in order to keep the state trunkline system functioning and safe. Each activity, whether it involves the exposing or moving of earth, the disposal of materials, the storing and use of chemicals, etc., has varying degrees of potential impact on water quality. Therefore, it is important that criteria be identified and developed so that certain activities which may have significant impacts on water quality can be identified and appropriate mitigation efforts can be implemented. Likewise, activities with no probable significant impacts can also be categorized and not need further water quality consideration. For example, cleaning ditches in proximity to a stream can have a potential impact through erosion of newly exposed soils. Mitigation may include barriers or filters to minimize sediment load reaching the stream.

The development of criteria should be related to rule changes that are being developed by the EPA National Pollution Discharge Elimination System (NPDES) regulations on stormwater discharge. These regulations will set forth permit requirements and criteria for stormwater discharges.

As a follow-up to the categorizing of project related activities based on certain criteria, an interagency Memorandum of Understanding (MOU) should be developed regarding the overall water quality coordination procedures between MDOT and DNR. The MOU should designate how the categorized activities should be used during project development.

RECOMMENDATION 2: AS A JOINT COOPERATIVE EFFORT MDOT AND DNR SHOULD INITIATE A FORMAL STUDY APPROACH TO EVALUATE AND ANALYZE THE COST AND EFFECTIVENESS OF ENVIRONMENTAL MITIGATION EFFORTS IMPLEMENTED TO REDUCE WATER QUALITY IMPACTS.

MDOT does implement various mitigation measures to minimize the impacts to streams, lakes, wetlands, and floodplains. Whether directly or indirectly, many of these mitigation measures have a positive effect on water quality. Some are considered inexpensive and routine, while others are implemented for site specific reasons, and can require much planning and design time, and can be quite expensive. As mitigation efforts are developed to protect water quality considerations at specific sites, it may be necessary to develop new engineering designs, or to modify existing engineering techniques without fully knowing if the final mitigation product will function as effectively or efficiently as anticipated. Therefore, it is important that certain site specific mitigation efforts be followed up with a formal study approach of the positive and negative aspects of the mitigation measure. This should include engineering, environmental and benefit/cost considerations.

RECOMMENDATION 3: MDOT AND DNR SHOULD COOPERATE IN THE DEVELOPMENT OF INFORMATION AND EDUCATION MATERIALS AND PROVIDE INFORMATION AND TRAINING TO LOCAL TRANSPORTATION AGENCIES REGARDING THE POTENTIAL IMPACT OF THEIR ACTIVITIES ON THE WATER RESOURCES OF THE STATE.

Michigan has over 117,000 miles of roadway which carry 178,600,000 vehicle miles of travel daily. Although the State trunkline system, which is under the jurisdiction of MDOT, includes only 9,250 center line miles of Michigan's total roadways, the trunklines carry over 50% of the total vehicle miles of travel. The other 50% of the State's travel on 108,000 miles of county and city roadways. Most of the State's high volume roads (over 40,000 vehicles per day) are under state jurisdiction.

This strategy report focuses on MDOT's 9,250 miles of trunklines. There are numerous transportation agencies located throughout the state who have jurisdiction over 108,000 additional miles of roadway and there is a need to inform, educate, and train these agencies concerning the provisions of this Transportation Strategy. The MDOT and the DNR are in the most advantageous position to accomplish

this. Therefore, as a joint cooperative effort, the MDOT and DNR should provide information and training to local transportation agencies concerning implementation of these provisions.

RECOMMENDATION 4: DNR, WITH ASSISTANCE FROM MDOT, SHOULD INVESTIGATE AND EVALUATE THE POTENTIAL FOR WATER QUALITY PROBLEMS FROM NON-ROADWAY MODES OF TRANSPORTATION.

This strategy report for reducing nonpoint source pollution from transportation related activities has focused on trunkline activities. Also, considered to be contributing to nonpoint source pollution are a number of non-highway modes of transportation, which includes: airports, railroads, and water-related transportation (recreational and commercial). However, due to time constraints and the lack of readily available information on pollutant contribution, the significance of non-highway modes contributing to nonpoint source pollution is not known.

Therefore, the DNR, with assistance from MDOT, should investigate and evaluate the potential water quality impacts that could result from these other modes and determine the problem areas that exist. Where potential problems are found, the DNR with assistance from MDOT should coordinate with the appropriate non-highway mode authorities to inform them of the findings and, as necessary, jointly develop a course of action designed to mitigate significant impacts to water quality.

#### Highway Design (Drainage) Current Practices

MDOT's Design Division is responsible for designing of highway projects. This Division includes in the design plans and specifications any special mitigation measures that were identified and justified during the planning stage of each project's development. Special mitigation measures require close cooperation between Transportation Planning Services, Design, Construction, and Maintenance Divisions. In addition, Design Division indicates on the plans all standard soil erosion control practices. These standard practices are indicated in the Design Standards plans.

MDOT's primary concern regarding highway runoff is to remove it from the travel lanes and to provide a positive flow of all collected runoff to an outlet that is able to legally convey the runoff downstream. MDOT-collected water comes from within the right-of-way (pavement and grassy margin), from groundwater intercepted by MDOT to maintain a dry roadbed (edge drains) or side slopes (bank drains), and from adjacent upslope properties outside the right-of-way.

MDOT's Design Division is in the process of revising their Design Manual. When completed, the entire manual will be a collection of guidelines to MDOT designers which will include basic guidelines for drainage while allowing appropriate treatments for each individual situation. The following items are discussed in Chapter 4 of the August 17, 1984, draft of the design manual.

- A. The treatment of surface drainage requires a careful engineering study and design after the line and grade for new roadways or the extent and limits of a widening or reconstruction project are determined. Highway drainage design involves two basic operations; estimating peak flows of runoff based on statistical hydrologic data and design of a drainage system to transport that flow.
- B. Under current law, MDOT is obligated to receive surface water from upstream areas and cannot retard the natural flow of surface water nor cause it to impound upon the upstream owner's land. Also, as an upstream property owner, MDOT does not have the right to divert surface water or cause water to concentrate upon lands of abutting downslope property owners without compensation to them.
- C. With regard to storm sewer and underdrain design:
  - 1. Existing combined sanitary and storm sewers should not be used for storm drainage purposes on a new roadway project or improvement.
  - 2. When groundwater is encountered it is discharged by edge drains, bank drains, and stone baskets, which connect into the storm sewer. Edge drains are placed to drain the subbase and intercept seepage water from the sides. Bank drains are sometimes placed in the back slopes to intercept seepage planes before they reach the bank to minimize erosion or sluffing. Stone baskets are provided to drain springs that occur below the roadway.
- D. Legal drainage outlets that may be considered are:
  - 1. Natural watercourses. For highway purposes a natural watercourse is defined as one that has not been artificially altered.
  - 2. County drains.
  - 3. Storm sewers or ditches owned by other than MDOT.
- E. Drainage outlets not to be initially considered unless drainage rights are purchased are: potholes, vacant land, farm tiles, combined sewers, small sags on the profile, or previously dyked drainage courses.
- F. A retention/detention basin may be designed as a retarding reservoir and settlement basin, metering out a predetermined discharge, when runoff from a road improvement may exceed the available capacity of a county drain, or when the increase may be detrimental to downstream properties. These basins are not routinely provided at all watercourses due to variable needs, additional cost, additional land area required, and the potential for liability that results from the open water.
- G. Open (grassy ditch) drainage is routinely provided along non-urbanized portions of roads due to the availability of right-of-way, and lower construction costs. Underground utilities may

prevent open ditch construction. Field sod is specified for the ditch bottom and sides where flows are anticipated to cause erosion. Where steep elevation changes occur in open ditches, such items as enclosed pipes, paved spillways and cobble ditches are specified to further control erosion.

When additional road lanes are added, the open ditch may be enclosed so that the road improvement can occur without purchasing and disrupting abutting property. Open ditches for drainage areas within MDOT's right-of-way are designed for a 50-year storm. The effects of a 100-year storm are checked for possible harmful damage.

MDOT prefers providing enclosed (pipe) drainage rather than open drainage in urban areas because of three main factors:

1. The additional right-of-way width is generally not available to accommodate an open ditch or is too costly or disruptive to acquire.
2. Conveying drainage in the buried pipe enhances the safety of motorists, pedestrians, and abutting owners.
3. Aesthetics are improved by curb which delineates the road edge and by grass extending to the sidewalk or property line.

Both enclosed and open drainage are discharged into wetlands if they are available, and if all affected landowners agree. Where drainage is not discharged into a wetland, enclosed drainage usually enters the receiving watercourse directly from the pipe. Open drainage outlets usually use a continuation of the open ditch but with heavy stone placed to prevent bank erosion as the water descends to the river.

H. Cross culverts that are located in floodplains should be designed for maximum anticipated flow meeting all design constraints at each individual site.

1. Normal procedure is to design culverts for flowing 0.9 full.
2. A headwater above the top of the culvert is allowed if a harmful backwater upstream will not result.
3. Outlet velocities shall not exceed existing stream velocities that would cause erosion without erosion control treatment. Outlet velocities less than 6 cubic feet per second (cfs) will generally not require special treatment if a headwall is used. Outlet velocities in excess of 6 fps will require provisions for erosion control treatment. This will vary somewhat with soil types.

The following is a design related recommendation:

RECOMMENDATION 5: MDOT, WITH ASSISTANCE FROM MICHIGAN DEPARTMENT OF AGRICULTURE AND DNR, SHOULD REVIEW ITS CURRENT DRAINAGE DESIGN PRACTICES DEALING WITH THE EFFECTS OF ROADWAY DRAINAGE ON WATER QUALITY.

There are a number of drainage design considerations which have significant potential for reducing pollutant loads from highway runoff and are generally low cost. MDOT should review and revise, as appropriate, their current drainage design practices with emphasis placed on using those which deal with the affect of highway drainage on water quality. These revisions should be included in the design manual with emphasis placed on:

- A. Include drainage provisions to allow for maximum use of vegetation controls consisting of grassy drainageways filter strips, and overland flow. These systems reduce pollutant loads by reducing the velocity of the open flow allowing sediment and suspended solids to settle out. Since many of the sediments contain adsorbed pollutants such as heavy metals, the pollutant load in the runoff may be reduced substantially prior to entering adjacent waterways, if the velocity of runoff is slowed over an adequate length of vegetation. Grass is the typical vegetation used.
- B. Utilize adjacent wetlands as filtering systems - The use of wetlands to remove pollutants from highway runoff can be very effective. Cattail areas within transportation right-of-way should be used when available. However, because of the variation in highway runoff quality and each wetland's ability to withstand changing water levels, treatment capacity and need should be evaluated on a site-by-site basis and should be coordinated with the DNR.
- C. Utilize infiltration systems as appropriate - Infiltration systems temporarily store surface runoff and allow the soil to act as a filtering mechanism for many pollutants as the water percolates into the soil. This water can either enter the aquifer or be collected and outletted into a watercourse.
- D. Eliminate site-specifically, the direct discharge of highway runoff into surface waters by utilizing detention basins - Detention basins reduce water velocity to permit suspended solids to settle out.

Although the above four design considerations can significantly reduce pollutant loads from highway runoff, they represent only a partial listing. The review and revision of current drainage design practices should include identifying and analyzing other highway drainage practices that can affect water quality.

#### Highway Construction Current Practices

The construction of a project proceeds according to the specific information provided on the design plans, the standard specifications for construction, and any required permits. A Project Engineer is assigned to each project and has the responsibility to see that all work is performed and completed by the Contractor in a satisfactory manner. The Project Engineer is often confronted with unforeseen problems, many of which are related to water; i.e. erosion, storage and disposal of muck

excavation, temporary stream crossings, and groundwater. The Engineer has the authority to remedy any problems that are encountered, which may involve anything from on-the-spot action to further coordination with the DNR and local county drain office to seek a solution.

The MDOT publication "Standard Specifications for Construction, 1984" is the standard for the basic requirements governing the materials, equipment, and methods used in construction contracts administered by the MDOT. MDOT also encourages counties and municipalities to reference these specifications in their construction contracts. Additional specifications written to apply to one specific project are called Special Provisions. The following items are discussed in the 1984 Standard Specifications for Construction:

- A. With regard to the control of water pollution and siltation;
  - 1. The Contractor shall conduct the work in a manner such that soil, fuels, oils, bituminous materials, chemicals, sanitary sewage, and other harmful materials, resulting from the construction of the project are confined within project limits and shall prevent its entry to watercourses, rivers, lakes, or reservoirs.
  - 2. The Engineer will advise the DNR of when work will begin on projects which have DNR permits.
  - 3. All applicable regulations of federal and/or state agencies and statutes relating to the prevention and abatement of pollution shall be complied with during the performance of the contract.
  - 4. Construction operations shall be conducted in such manner as to reduce erosion to the practicable minimum to prevent sedimentation damaging watercourses, streams, or lakes.
- B. With regards to protecting plant life, all vegetation which is not designated on the plans or by the Engineer to be removed shall be carefully protected from damage or injury during all construction operations. Any trees or shrubs that are not designated to be removed but are damaged by the Contractor's operations shall be repaired or replaced by the Contractor as directed by the Engineer.
- C. Cofferdams are substantially watertight steel sheeting enclosures driven into the stream bed or bank which permit construction of the substructure or subfooting in the dry and without damage to the work or environment. Alternate methods used in lieu of cofferdams will be permitted by authorization only. Such authorization will be considered only after receipt of a DNR permit for the alternate method. When called for on the plans or provided by authorization, cofferdam sheeting shall be left in place as required.

Pumping shall be done from a sump located outside the forms in such manner as to avoid injury to the concrete. The cloudy effluent shall not be pumped directly into the surrounding water but shall be

directed into siltation basins or other facilities which will remove the solids.

- D. Concerning stream channel excavation, all required work in the new channel shall be completed prior to diverting the stream flow to the new channel. All channels shall be maintained and kept reasonably free from debris until final acceptance of the channel.

Sediment traps excavated in the channel are left in the stream bed. Temporary and abandoned channels are backfilled to the elevation of the surface of the adjacent ground or as required to obtain the desired contour.

The Project Engineer is responsible for assuring that channel excavation methods, restrictions, and instructional guidance that are contained on the plan sheet and on any Special Provision written for each specific channel change are implemented in the field.

- E. Payment is made for both permanent and temporary soil erosion and sedimentation control measures, plus for the maintenance of sediment basins. Contract items specify:

1. Temporary or permanent sedimentation controls shall be constructed, to the extent possible, prior to commencing grubbing operations. Grubbing operations shall be scheduled so that grading operations can follow immediately thereafter; otherwise temporary erosion and sedimentation controls may be required between successive construction stages.
2. All grading sections shall be brought directly to final grade as the project progresses. Permanent soil erosion controls for all slopes, channels, ditches, or any disturbed land areas shall be completed within 15 calendar days after final grading of the section or any portion thereof. Where it is not possible to permanently stabilize a disturbed area, temporary erosion controls shall be implemented within 30 calendar days after cessation of grading activity, whether or not the area has been brought to final grade. All temporary soil erosion controls shall be maintained until permanent soil erosion controls are completed.
3. The surface area of erodible earth material exposed at any one time will be limited to 50 stations (5,000 feet) of dual roadways (100 stations, 10,000 feet, of single roadway) for grubbing operations and a like amount for excavation and embankment operations, except that the Engineer may reduce or increase the limits of exposed surface area dependent on grading progress and application and effectiveness of temporary and permanent erosion controls.

The Contractor shall not cause disturbance to lands and waters outside the grading limits unless such work is found necessary and approved by the Engineer.

Where work is conducted outside the right-of-way, such as borrow operations, waste or disposal areas, haul roads and storage sites, temporary and permanent erosion and sedimentation controls shall be provided by the Contractor and approved by the Engineer. The areas of erodible land exposed by grading operations at these sites will be subject to the approval of the Engineer.

4. The Contractor shall maintain all temporary erosion and sedimentation controls during the period that the temporary controls are required and all permanent erosion controls until the contract has been completed and accepted. Such maintenance shall consist of the repair of all damaged areas, replacement of lost facilities, and periodic removal of sediment.
  5. Temporary erosion and sedimentation controls shall be removed or obliterated when the permanent controls are in place unless ordered to be left in place by the engineer. Mulch placed for temporary erosion control shall be incorporated into the slope or removed prior to placement of topsoil and/or permanent seeding and fertilizing operations. Care shall be exercised during such removal to minimize erosion or sedimentation of watercourses.
- F. The design plans include a lump estimate for field drains, edge drains, or bank drains. The locations and exact amounts of underdrains are determined by investigation, which is conducted during grading operations.

The following is a construction related recommendation:

RECOMMENDATION 6: MDOT, WITH ASSISTANCE FROM DNR, SHOULD REVIEW THEIR CURRENT SOIL EROSION AND SEDIMENTATION CONTROL PRACTICES AND DESIGNATE THE ENGINEER OF CONSTRUCTION TO BE RESPONSIBLE FOR PROJECT ACTIONS REQUIRED BY THE SOIL EROSION AND SEDIMENTATION CONTROL ACT ON TRUNKLINE PROJECTS.

The Soil Erosion and Sedimentation Control Act of 1972 (P.A. 347 of 1972) is considered good basic legislation for the control of soil erosion and sedimentation. MDOT complies with this Act as an Authorized Public Agency. However, much improvement in MDOT's overall soil erosion and sedimentation control program could be made. Because of the numerous people involved with and responsible for erosion control within MDOT and the variable climate, topographical, soil and vegetation conditions found throughout Michigan, it would be very beneficial for MDOT to designate a position to be responsible for the continued action required by P.A. 347. The Transportation Task Group is recommending that the Engineer of Construction position be designated to assume this responsibility on construction projects and to be accountable for actions required by the Act for trunkline projects. The Engineer of Construction currently is the Division Administrator for Construction Division and has responsibility to oversee all MDOT trunkline construction related activities.

Also, the Task Group is recommending that the Transportation Planning Services Division, within the Bureau of Transportation Planning, continue its advisory role to the Engineer of Construction on erosion/sedimentation items. Responsibilities of this Division currently include overall department environmental impact review and coordination, reviewing design plans, and for reviewing permit applications before they go to the DNR to assure appropriate soil erosion mitigation measures have been included, and for conducting field reviews of construction projects to assure compliance in the field.

The Engineer of Construction, in cooperation with Materials and Technology Division, should be responsible for reviewing MDOT's current soil erosion and sedimentation control practices, with emphasis placed on documenting the effectiveness or ineffectiveness of some of the current erosion control practices as well as new practices and materials as they are used, and to document and distribute information throughout MDOT on erosion control. This would provide an exchange of knowledge and experience of MDOT personnel, provide a greater degree of consistency on trunkline projects throughout the state, and promote the importance of water quality considerations.

Also, additional emphasis should be placed on stricter enforcement of the provisions of P.A. 347. MDOT has been designated as an Authorized Public Agency under P.A. 347. As such, MDOT administers its own construction projects without obtaining project by project approval of its sedimentation and erosion control plan by another agency. MDNR should review and update its administration and enforcement of the Act to reflect strict compliance and consistency on a statewide basis.

#### Highway Maintenance Current Practices

Michigan's total roadway network consists of approximately 117,000 miles of highways, streets, and roads. This includes approximately 9,500 miles under state trunkline jurisdiction, with the remaining miles under county and city jurisdiction. Although only eight percent of Michigan's roads fall under state jurisdiction, these roads carry over 50 percent of the total vehicle miles traveled. The MDOT Maintenance Division is responsible for maintenance activities occurring within MDOT owned rights-of-way, even though most work is actually done by private contractors and local governmental agencies.

As related to nonpoint source pollution, two primary activities are of concern. These include summer herbicide usage and winter deicing programs. The current operating practices of these are discussed as follows.

#### A. Herbicide Usage

MDOT uses herbicides primarily for controlling unwanted vegetation. More specifically, MDOT currently uses herbicides for the following reasons:

1. To Maintain Clear Vision Areas - For safety reasons, it is necessary at all crossroads and interchange areas that tall growing vegetation be kept a specified distance back from the roadway. Tall grasses, weeds and shrubs are controlled at these locations so that drivers can see approaching vehicles. Along all stretches of roadway, it is important to control roadside vegetation which can hide animals. During 1984, there were more than 20,000 deer-car collisions reported in Michigan on its total roadway network. In addition, along some sections of roadway, it is necessary to control the larger shrubs and trees within the right-of-way which might become a crash obstacle to a car leaving the roadway.
2. To Control Noxious Weeds - In areas where it is impractical to mow because of steep grades or embankments, unwanted weeds can be removed by the use of herbicides.
3. To Control Poisonous Weeds - It is necessary to control poisonous plants at any location where a person might come into contact with them. This includes roadside parks, rest areas and adjacent to roadways where a person may be walking or changing a flat tire.
4. To Control Pollen Bearing Plants - It is necessary to control pollen bearing plants at the same general locations as stated for controlling poisonous weeds, which includes roadside parks, rest areas and adjacent to roadways.

Herbicides currently used by MDOT (July 1985) include:

<u>Common Name</u>	<u>Chemical Name</u>
2,4-D	2,4 Dichloropheoxyacetic acid
Garlon	3,5,6-trichloro-2-pyridinyloxyacetic acid
Telar (chlorsulphuror)	*
Velpar L (Hexazinone)	3-cyclohexyl-6 (dimethylamino)- 1-methyl-1-3-5-triazine-2-4-(1H,3H)-dione
Princep (Simazine)	2-chloro-4,6-bis (ethylamino)-5-triazine
Karmex (Diuron)	3-(3,4-Dichlorophenyl)-1,1-dimethylurea
Banvel	2-methoxy-3,6-dichlorobenzoic acid
Tordon (Picloram)	4-Amino-3,5-6-trichloropicolinic acid
Roundup (Glyphosate)	isopropylamine salt of N-(phosphonomethyl) glycine
Rodeo (Glyphosate)	(same as Roundup with differing surface active agent)
Revenge (Dalapon)	2,2-Dichloropropionic acid

\*2-chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) aminocarbonyl] benzinesulphonimide.

All of these herbicides have been designated for agricultural and/or residential use except Telar, which can be used only adjacent to highways. Also, the Department of Agriculture (MDA) now has approved Rodeo as an acceptable herbicide that can be used in waterways.

These herbicides are applied in a number of ways, depending on what vegetation is to be controlled and where it is located. All applications made by MDOT are ground oriented. No aerial applications are made. The two primary methods of applying herbicides are:

1. Vehicle Mounted Spray Systems - Most herbicides are applied with hydraulic equipment moving along the shoulder of the road. Nozzle types and pressures are closely controlled to ensure that no drift gets outside the right-of-way.
2. Back Pack Sprayer - This sprayer is used to control individual plants, or small concentrations of plants.

MDOT employees and any contractors working for MDOT are required to make herbicide applications in accordance with MDA, DNR and USDA restrictions and regulations. Also, all federal, state, and local laws and regulations governing the furnishing and use of all safeguards, safety devices, and protective equipment must be complied with.

The crews making applications must be licensed in accordance with the pesticide application law as it applies. For contracted work, no work is to be done unless MDOT's engineer, or an authorized representative, is present. In the case where a contractor needs more than one vehicle to complete his task, MDOT requires that each vehicle must be accompanied by a MDOT inspector during herbicide application. (However, in the future, it is anticipated that MDOT will be using performance contracts where payment is based on whether or not the desired results are obtained. These will not have MDOT inspection during application.).

In addition to acting under the previously mentioned procedures, MDOT also takes a number of other precautions to ensure minimal adverse harm to the environment. These precautions are:

1. MDOT has not applied herbicides directly to any streams or waterways of the state because acceptable herbicides were not available for this use. However, the Department of Agriculture now has approved Rodeo as an acceptable herbicide that can be used in waterways. This herbicide will be used by MDOT to open up drainage ways that are filled with vegetation and backed-up water is a problem.

When making applications near water, the following precautions are taken:

- a. Thickened sprays may be used to reduce drift as conditions warrant.
- b. Application is made only under specified weather conditions.
- c. In general, the mixing of solutions is done away from streams and ditches. When loading water for mixing herbicides on trucks, it is necessary to pump or siphon from a watercourse. However, all application equipment

- has special anti-siphon features so that herbicides will not be discharged to the watercourse.
- d. Adherence to label instructions to assure that any herbicides restricted for use near streams are not used near watercourses.
2. To reduce impacts on lands adjacent to trunkline right-of-way, MDOT takes the following precautions:
    - a. In general, vegetation control is not done back to the right-of-way fence. Only brush and weeds 30-40 feet from the roadway are being treated. Full width right-of-way control is being conducted only in areas adjacent to commercial and residential development and around landscape materials.
    - b. Work is suspended if the wind velocity is high enough to carry the spray outside the right-of-way. Also, an effort is made to stop work at least one hour before a rain and not to resume work until all free water has stopped dripping from the plants.
    - c. Herbicide applications are carried out in conjunction with local weed problems and local conditions.
  3. A number of general precautions are taken by MDOT and its contractors. These precautions are:
    - a. All equipment must be suitable for the job and in adequate working condition.
    - b. Materials must be shipped in new containers fitted with tamper-proof seals. Materials may be tested by MDOT before they are used.
    - c. All containers of material are labeled to indicate the lot number, chemical materials which constitute the active agent, the concentration of active agent in pounds per gallon, all precautions necessary in handling, and volume of contents of each.
    - d. All herbicides are applied according to manufacturer's specifications approved by the MDA.
    - e. The handling of chemicals is done with appropriate safety equipment.
    - f. All spraying operations are performed from the shoulder of the roadway with the exception of curbed sections.

The following is a herbicide maintenance related recommendation:

RECOMMENDATION 7: MDOT, WITH ASSISTANCE FROM THE TOXIC SUBSTANCE CONTROL COMMISSION, DNR AND MDA, SHOULD ANNUALLY EVALUATE AND REPORT TO THE

MICHIGAN ENVIRONMENTAL REVIEW BOARD ON ITS HERBICIDE APPLICATION PROGRAM.

As a means of improving its overall herbicide application program, MDOT should evaluate:

- A. The need for controlling certain types of vegetation in specific situations. This primarily relates to the need to control noxious weeds and pollen bearing plants.
- B. The need to use vehicle mounted hydraulic spraying systems which apply herbicides to a general area from a truck moving slowly along the shoulder of the road.
- C. The need to annually publish information on what herbicides MDOT anticipates using in the upcoming year, how much will be used, and where and how they will be applied.

B. Salt Usage

The maintenance operation of the state trunkline system involving salt use is the responsibility of the MDOT and is carried out by both MDOT employees and contractors. In 62 of Michigan's 83 counties, MDOT contracts the county road commissions to maintain state trunklines within their boundaries. In the other 21 counties, trunklines are maintained by MDOT employees. Also, MDOT has contracts with approximately 150 municipalities to do maintenance work on state trunklines. In all cases, the work is under the supervision of the Maintenance Division of MDOT.

To provide adequate winter maintenance service, yet restrain winter maintenance expenditures in order to remain within or below budgeted funds, each trunkline has been classified by traffic volumes and each classification has been assigned a minimum level of maintenance during winter storm conditions, as follows:

- For trunklines that have winter Average Daily Traffic (ADT) volumes of 3,500 and over, which includes much of the freeway system and heavily traveled urban area roads, MDOT's goal is to provide a pavement surface generally bare of ice and snow. Winter maintenance forces blade snow and ice from the pavement surface and apply deicing chemicals and/or abrasives as needed to provide a reasonably bare pavement.
- For trunklines that have winter ADT volumes of 1,000-3,500 vehicles, MDOT's goal is to provide a pavement surface generally bare of ice and snow in the center portion of the roadway wide enough for a vehicle in each direction to have one-wheel on clear pavement. Deicing chemicals and/or abrasives are applied only as needed to reach this goal.
- For trunklines that have winter ADT volumes of less than 1000, MDOT's goal is to provide a pavement surface that is passable though snow covered. Winter maintenance forces blade or plow

snow from the traveled portion of the road, leaving the pavement with a thin snow cover. Abrasives and/or deicing salts are used only on hills, curves, and intersections except during heavy wet snow or sleet conditions, when additional portions of the roadway may need to be treated.

The primary deicing chemical used in Michigan and nationally is sodium chloride (NaCl or rock salt). This chemical is preferred because it is inexpensive (approximately \$22.00/ton), relatively easy to handle, and is the most effective deicer presently available.

MDOT has a winter operations guide which shows what maintenance personnel should do during and after a storm for various temperatures (See Appendix B). For example; during a snow storm, if the temperature is above 20°, the guide indicates to blade as required, apply no sand, and apply 400 pounds of salt per mile. After the storm, blade to bare pavement, do not sand, and apply salt as needed.

#### Salt Storage Facilities

MDOT now has 100% of its salt storage facilities meeting DNR's criteria for storage and containment of salts. All the storage facilities for pollutants used (oils, paints, salts, etc.) by MDOT are covered under a Pollution Incident Prevention Plan which is filed with the DNR.

Currently, almost all of MDOT's salt is in completely enclosed shelters. All of the old storage sheds are being converted to be enclosed and on hard pads. All salt that is outside is put on a bituminous pad that is encircled by a curb. The pad's drainage is collected directly into a vault, which is periodically pumped out and applied to specific road situations or may be outletted to a sanitary sewer. These outside salt storage piles are also covered with a tarp.

#### MDOT Salt Task Force

An MDOT Task Force has been established to study possibilities for reducing salt use and seek alternatives to its use on Michigan's state highway system. It includes members of MDOT's maintenance, environmental, and research staffs. Representatives of the Legislature, DNR and Department of Public Health (DPH) also have been invited to participate.

The task force is looking at ways to use salt more sparingly in some situations and determine if there are effective alternatives to salt that are not already being used. Study areas include:

- Reduction or elimination of salt use at selected sites near drinking water sources and important plant and animal habitat areas sensitive to salt accumulations. MDOT will work with DPH and DNR to identify these areas.

- Continued investigation into the use of sand coated with calcium magnesium acetate (CMA), a chemical being studied as a possible salt substitute. CMA currently costs approximately \$400 per ton, versus \$22 per ton for salt, and is not being produced on a regular basis.
- Use of a higher ratio of sand mixed with salt on rural highways with lower traffic volumes and no enclosed drainage.
- Investigate the feasibility of formulating more specific guidelines for salt usage or usage of a salt substitute based upon specific weather conditions.

MDOT is taking other immediate steps to control salt use on trunklines. In 1985 MDOT purchased 20 automatic salt spreaders which are ground speed controlled and will be installed on snow and ice removal trucks for use in the winter of 1985/86. When the truck's speed changes, the amount of salt spread will be automatically adjusted. The new system will eliminate operator error resulting in the uneven distribution of salt. Currently, salt spreaders are controlled manually by the drivers, who often have a difficult time just managing their equipment on slippery roads and in snowstorms. It is planned that 33 additional automatic salt spreaders be purchased in 1986. At that time MDOT will own approximately 50% of the automatic salt spreaders in the entire country.

MDOT will continue its annual training program for all equipment operators in winter maintenance operations, including salt spreading. MDOT directly maintains state highways in 21 counties, but the work is performed by county road commissions under contract with MDOT in the other 62 counties and in over 150 municipalities. The counties and cities must comply with MDOT standards on snow and ice removal operations on trunklines, and MDOT often helps them upgrade and modify their equipment to conform with MDOT standards.

#### Brine Use for Ice and Dust Control

A large number of Michigan counties and municipalities utilize brine for ice and dust control. It is known that brine constituents, especially sodium, can be detrimental to health if allowed to contaminate well water. Contaminants of brine, such as benzene, may have an adverse health impact at very low concentrations. Thus, it is of major economic and toxicological importance to determine if it is possible to apply brines to Michigan roads without causing deleterious environmental and health effects.

In order to resolve whether brines and their alternatives can be safely applied, the Toxic Substance Control Commission, in conjunction with MDNR and MDOT, will conduct an investigation to: (1) Review and evaluate the chemical constituents of brine and its alternatives and its degree of variability. (2) Identify and measure the

types of contaminants and their concentrations in brine and its alternatives (additional sampling and analyses will probably be required to fully characterize the contamination level in Michigan brines), and (3) Determine under what guidelines a management program for brine and its alternatives could be safely instituted.

Coordination between TSCC, Department of Natural Resources and the Department of Transportation will be essential to the success of this investigation.

The following is a deicing maintenance related recommendation:

RECOMMENDATION 8: MDOT SHOULD CONTINUE TO EVALUATE ITS WINTER MAINTENANCE PROGRAM AND ATTEMPT TO ESTABLISH MICHIGAN AS THE FOCAL POINT OF EXPLORING ALTERNATIVES TO DEICING SALT IN THE GREAT LAKES REGION.

MDOT's recently established task force is currently looking into the possibility of reducing salt usage and determining if there are effective alternatives to salt that are not currently being used. This task force shall continue its efforts, with emphasis placed on evaluating the cost effectiveness, applicability and flexibility of calcium magnesium acetate (CMA) to Michigan situations. Also, the task force should be expanded to become an interagency effort which should include representatives from the Michigan Departments of Commerce (MDC), Natural Resources and Public Health, the Toxic Substance Control Commission and the Attorney General's Office.

IMPLEMENTATION PLAN

Following is a summary of the steps necessary to implement the Transportation-Related Nonpoint Source Pollution Strategy.

<u>Recommendation</u>	<u>Lead Agency</u>	<u>Cooperating Agencies</u>	<u>Target Date</u>	<u>New Budget Required</u>	<u>Action</u>
1. Criteria	MDOT DNR		July, 1986	No	Categorize Transportation Activities
2. Mitigation	MDOT DNR	Local Agencies	July, 1986	Yes	Develop Water Quality Studies
3. Information/ Education	MDOT	Local Agencies DNR	Nov., 1985	Yes	Develop Program
4. Non-Highway Modes	DNR	MDOT	July, 1986	Yes	Develop Program as Necessary
5. Drainage	MDOT	MDA DNR	July, 1986	No	Improve Current Program
6. Soil Erosion	MDOT	DNR	July, 1986	No	Improve Current Program
7. Herbicides	MDOT	MDA DNR TSCC	April, 1986	No	Review Current Program and Develop Reporting Procedure
8. Winter Maintenance	MDOT	TSCC DNR MDPH MDC	July, 1986	No	Develop Program

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Appendix A

Table A-1. Summary of study site characteristics selected by Gupta, et al. (1981).

Location	Type	ADT	Precipitation In./yr		Drainage area, acres			Surface type	Highway length, ft	# of lanes	Type of selection	Curb/ barrier	Outfall/manhole size, in.
			Total	Snowfall	Total	Paved	% Paved						
Milwaukee, WI I-794	Urban	53,000	30	40-60	2.1	2.1	100	Concrete	813	8	Elevated	Yes	24
Milwaukee, WI Hwy. 45	Urban	85,000	30	40-60	106.0	33.0	31	Concrete	9,500	6	Cut & fill	Yes	72
Milwaukee, WI Hwy. 45	Urban	35,000	30	40-60	2.5	0.0	0	Grass cover	500	-	Fill	-	15
Harrisburg, PA I-81	Rural	24,000	40	20-30	18.5	5.0	27	Concrete	2,000	6	Fill	No	36
Nashville, TN I-40	Urban	88,000	55	1-20	55.6	20.5	37	Concrete	6,200	6	Cut	Yes	48
Denver, CO I-25	Urban	149,000	20	60-100	35.3	13.2	37	Asphalt	3,600	10	Fill	No	30

Appendix A

Table A-2. Average heavy metal concentrations in highway runoff for the study sites selected by Gupta, et al. (1981). Ranges in concentrations are included in parentheses.

Site Location	Cadmium (µg/l)	Copper (µg/l)	Lead (µg/g)	Mercury (µg/l)	Zinc (µg/l)
Milwaukee, WI I-794	68 (10-400)	159 (10-660)	2900 (900-13100)	2.57 (0.13-24.0)	690 (140-3400)
Milwaukee, WI Hwy.-45	44 (10-90)	135 (10-880)	1200 (400-6600)	5.18 (0.20-67.0)	550 (200-1900)
Milwaukee, WI Hwy.-45 (grass)	47 (20-100)	83 (10-230)	210 (50-700)	1.52 (0.25-11.5)	180 (70-340)
Harrisburg, PA I-81	25 (10-70)	45 (10-100)	100 (50-200)	4.86 (0.25-49.0)	80 (10-230)
Nashville, TN I-40	27 (10-60)	70 (10-200)	500 (20-1700)	1.75 (0.50-6.7)	280 (100-610)
Denver, CO I-25	20 (10-80)	110 (30-260)	450 (300-1800)	1.09 (0.25-4.0)	720 (330-1500)

## APPENDIX B

MDOT has a number of performance standards related to winter salting/sanding/blading operations on state trunklines. These are described as follows:

1. When applying salt on continuous stretches of highways to eliminate general slippery conditions, the recommended work method is:
  - Blade accumulated snow from the surface before applying salt. (Blading performed at the same time as salting is part of Continuous Salting.)
  - Apply salt at an application rate of 400 pounds per mile under most conditions. Cab application settings should be set at the average traveling speed which should be maintained for a uniform application.
  - Consider general temperature and weather conditions in deciding to Continuous Salt.
    - Below 10 degrees - Sanding is preferred
    - 10-20 degrees - Continuous Salting or Sanding
    - Above 20 degrees - Continuous Salting is preferred
  - For changing conditions refer to the Winter Operations Guide.
  - Avoid salting too early during extreme cold and falling temperatures. Salt wets the pavement and hazardous conditions may develop with refreezing.
  - Place chemicals on the centerline of the roadway with the auger - except when treating superelevated curves and ramps or widened sections of roadway.
  - After salting it is good practice to allow time for melting before blading again (longer as the temperature drops below 20 degrees) unless the storm has ended.
  
2. When applying salt on hazardous or troublesome spot locations such as hills, curves, stops or drifting locations, the recommended work method is:
  - While spot salting, blade any accumulated snow.
  - Apply salt at an application rate of 400 pounds per mile under most conditions.
  - Consider general temperature and weather conditions in deciding to spot salt.
    - Below 10 degrees - Sanding is preferred
    - 10-20 degrees - Spot Salting or Sanding
    - Above 20 degrees - Spot Salting is preferred

For changing conditions refer to the Winter Operations Guide.

- Avoid salting too early during extreme cold and falling temperatures. Salt wets the pavement and can cause icy conditions. Allow snow to blow off the pavement until hazardous conditions develop.
3. When applying sand at spot hazardous locations or over continuous sections of highway to increase traction on slippery surfaces, the recommended work method is:
- Blade loose snow from the surface before applying sand. (Blading performed at the same time as Sanding is part of this activity.)
  - Apply sand at an application rate of 3/4 cubic yard per mile under most conditions.
  - Sand is most effective to provide traction under severe temperature conditions below 20 degrees but will not remove ice and snow. For the most effective use of sand refer to the Winter Operations Guide.
4. An effective treatment for icy bridge decks appears to be a salt and sand mixture wetted with calcium chloride solution. It has a better ability to stick to the icy surface before it can be imbedded in the ice layer.
5. For all winter maintenance not covered in the items above, the performance standards indicate that the materials and equipment to be used is "as needed." Examples of such winter maintenance work are:
- Snow removal (municipal streets, intersections, snow storage areas, bridges, park & ride lots, etc.)
  - Stockpiling and cleanup of salt, sand, and mixtures for winter maintenance.
  - Thawing frozen culverts.
  - Opening frozen inlets and other frozen drainage structures.
  - Moving snow from drainage.
  - Washing or cleaning of trucks or other winter equipment after a storm.
  - Calibrating chemical spreading equipment.